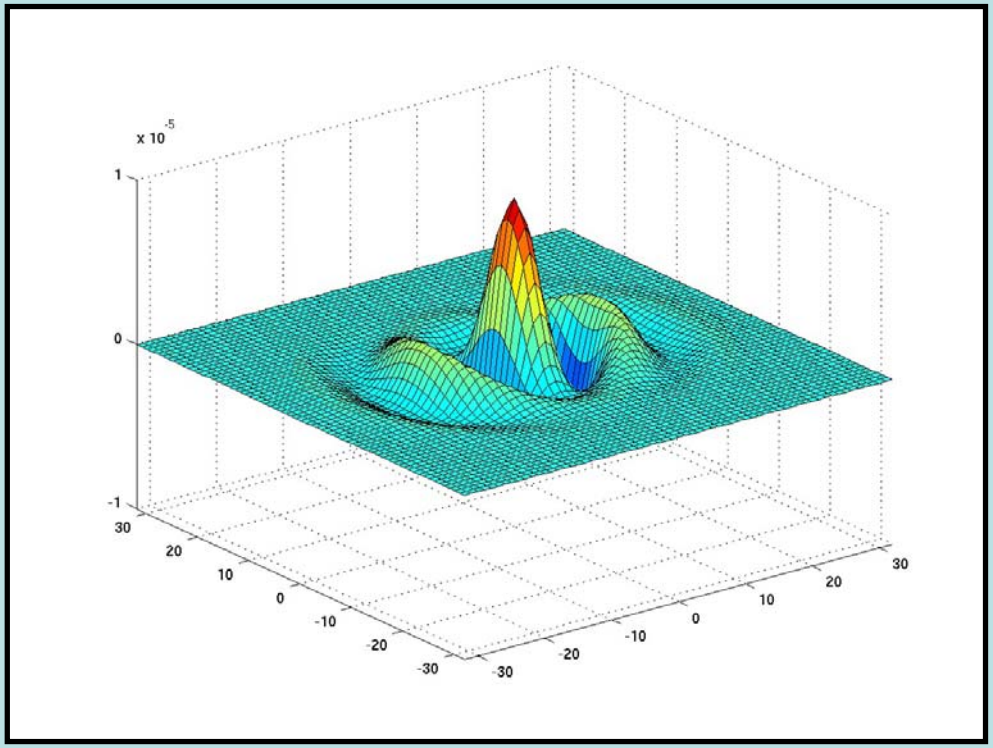
Ohm's Laws for Spintronics



x-component of the spin diffusion cloud for a spin initially in the x direction – Burkov +AHM (2003)

$$\frac{\partial N}{\partial t} = D\nabla^2 N + \Gamma_{sc}\mathbf{B}\cdot\mathbf{S},$$

$$\frac{\partial S^a}{\partial t} = \left(D\nabla^2 - \frac{1}{\tau_a}\right) S^a + \Gamma_{ss}\left(\mathbf{B}\times\mathbf{S}\right)_a + \Gamma_{sc}B^a N,$$

The equation at the bottom of this transparancy provide a general description of charge and spin transport in a two-dimensional electron gas with spin-orbit interactions. They were derived by myself and a grad student – Anton Burkov (now at UCSB). We have put this on cond-mat just recently.

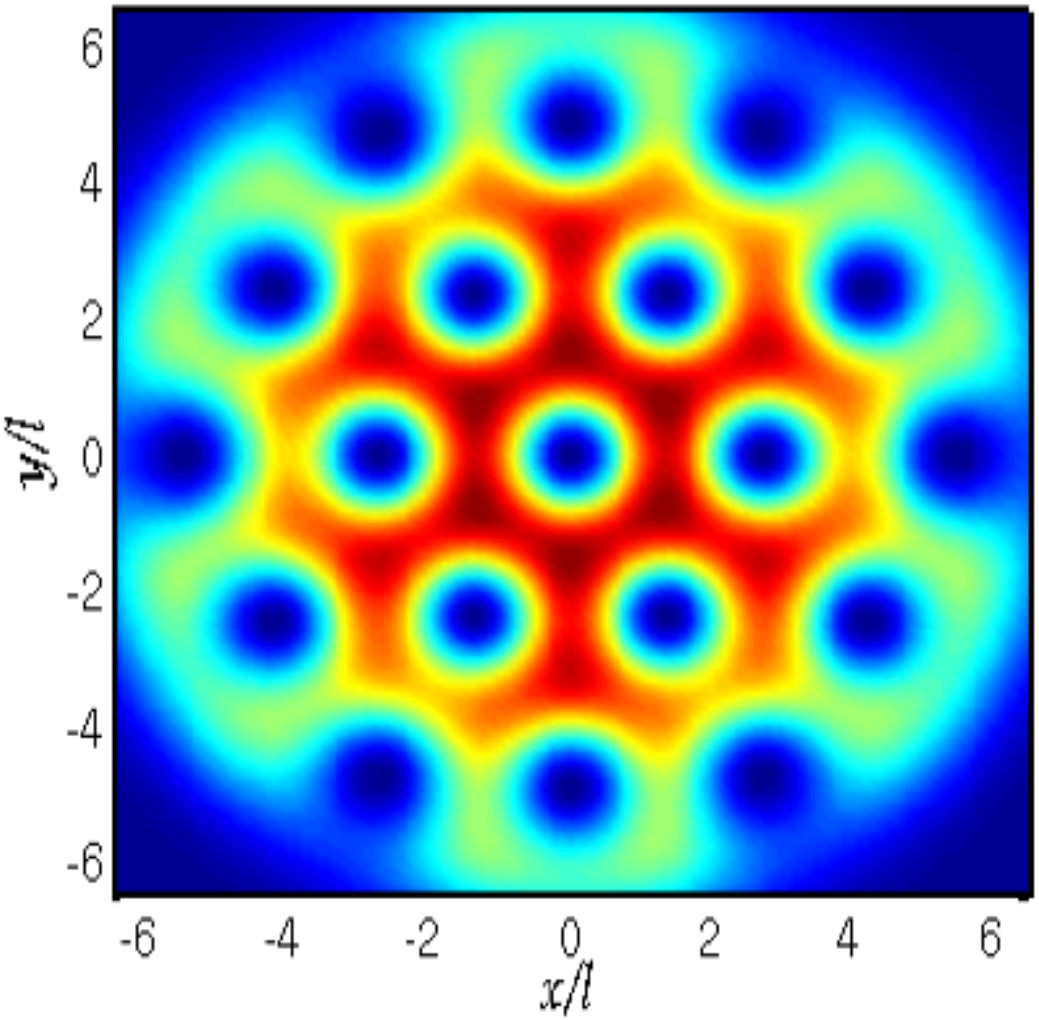
I consider these to be very important results since they allow transport of spin-polarized charge to be modelled correctly for the first time. I will be devoting some time in the next while applying these equations. The coefficients that appear in the equations are the ordinary diffusion coefficient D,

The spin-relaxation times, and two coefficients that represent new physics including spin-galvanic, magneto-electric and spin-Hall effects.

The illustration shows how the spin-density spreads out when an electron with a particular spin-orientation moves diffusively though a spin-orbit coupled system. The coefficients of the above equations are related to spatial moments of these distribution functions – looking how a diffusion cloud for one spin-orientation develops starting from a spin with the same or a different orientation.

Boson QHE and Vortex Lattices

Phys. Rev. Lett. 90, 120401 (2003)



This is a `pretty' illustration from work that we have been doing on cold-atom bosons in the quantum Hall regime, in rotating atom clouds. This is a picture of a Boson vortex lattice as it approaches the regime where interactions destroy the vortex lattice and the particles organize themselves instead into incompressible quantum Hall states. This regime is very interesting from a basic physics point of view, because it demonstrates that a fluid state of bosons doesn't necessarily have to have a superfluid state; something that was not recognized previously. This work is being done in collaboration with my postdoc Jairo Sinova (now on faculty of TA&MU) and Charles Hanna